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CS 480 WA2
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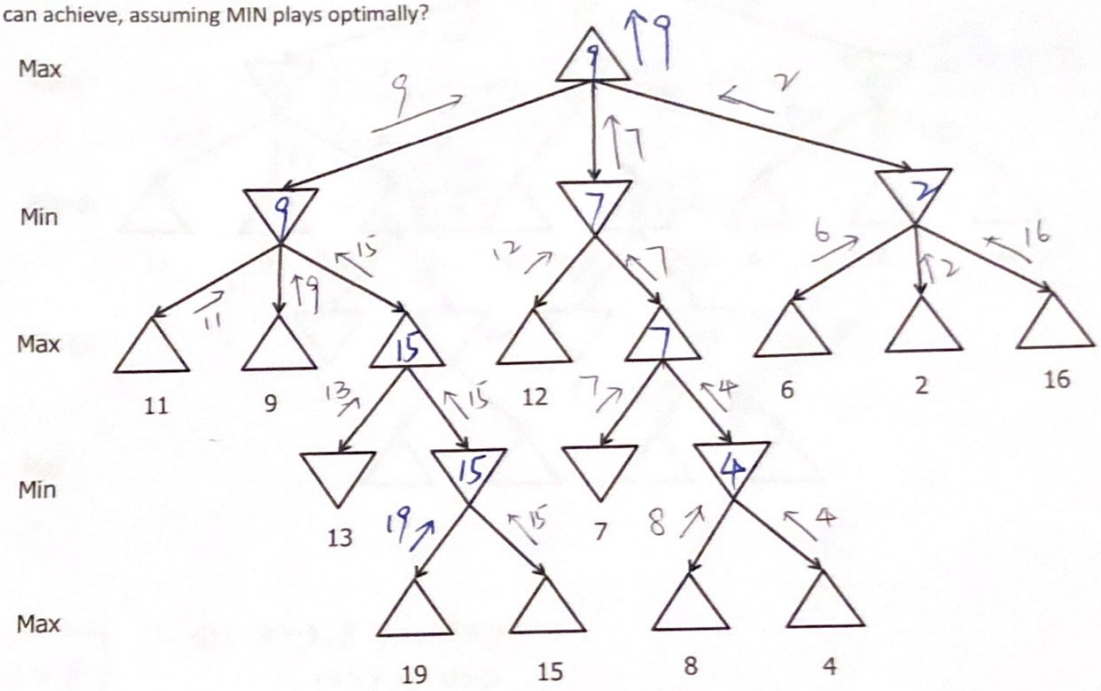
CS 480 – WRITTEN ASSIGNMENT 2

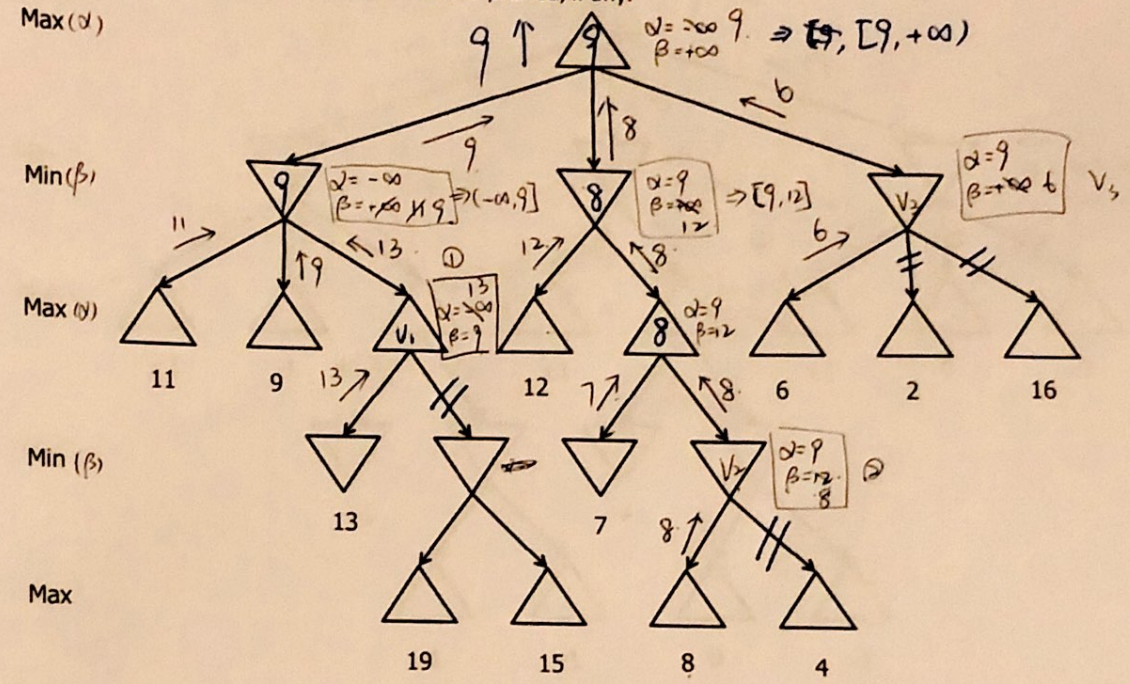
There are five questions. Please submit your solutions through blackboard.

1. Hand trace the mini-max algorithm on the following game tree. What is the maximum utility that MAX can achieve, assuming MIN plays optimally?



Therefore, the maximum utility that max can achieve, is 9.

2. This is the same game tree of question 1. Hand trace the alpha-beta search. Show the updated bounds on the nodes. Clearly mark which branches are pruned, if any.



$\alpha \geq \beta$

① $\alpha = 13, \beta = 9$ $\alpha \geq \beta$

$13 > 9 \Rightarrow \alpha \geq \beta$

therefore, pruning.

$V_1 \geq 13$

② $\alpha = 9$ $\beta = 8$.

$9 > 8 \Rightarrow \alpha \geq \beta$

$V_2 \leq 8$ pruning

③ $\alpha = 9$ $\beta = b$

$9 > b \Rightarrow \alpha \geq \beta$

pruning.

$V_3 \leq b$.

therefore, the utility is 9

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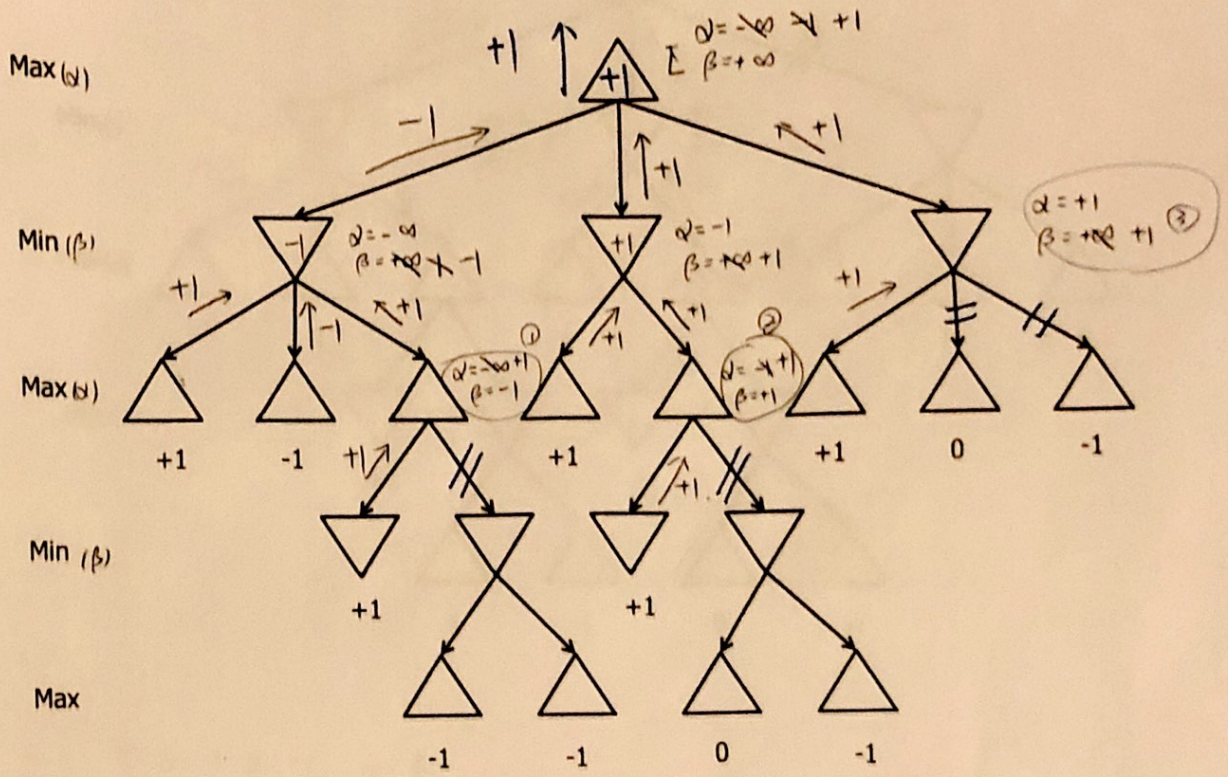
3. Hand trace the alpha-beta search on the following game tree. Show the updated bounds on the nodes. Clearly mark which branches are pruned, if any.



$\alpha \geq \beta$.

① $\alpha = 1 \quad \beta = -1$

$1 > -1 \Rightarrow \alpha > \beta$

pruning

② $\alpha = +1 \quad \beta = +1$

$1 = 1 \Rightarrow \alpha = \beta \Rightarrow \alpha \geq \beta$

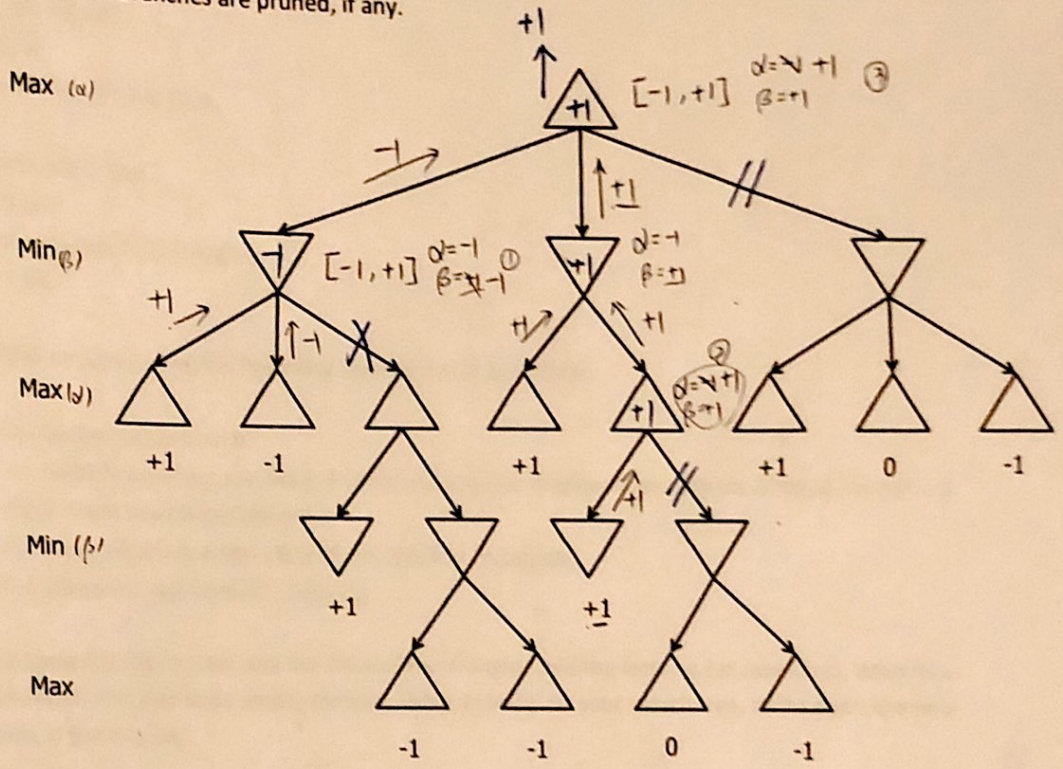
pruning.

③ $\alpha = +1 \quad \beta = +1$

$1 = 1 \Rightarrow \alpha = \beta \Rightarrow \alpha \geq \beta$

pruning

4. This is the same game tree of question 3. Assume we modify the alpha-beta search so that the initial bounds at the root of the tree are NOT $(-\infty, +\infty)$. Instead, assume the initial bounds at the root of the tree is $[-1, +1]$. Hand trace the alpha-beta search. Show the updated bounds on the nodes. Clearly mark which branches are pruned, if any.



$\alpha \geq \beta$

① $\alpha = -1$ $\beta = -1$ $\alpha = \beta$

pruning

② $\alpha = 1$ $\beta = 1$ $\alpha = \beta$

pruning

③ $\alpha = 1$ $\beta = 1$ $\alpha = \beta$

pruning

5. We are given the following CSP problem.

The variables and domains are as follows.
A: {4, 5, 6, 7, 8}
B: {10, 20, 30, 40}
C: {2, 3, 4}
D: {28, 43, 56, 77, 94, 114}

The constraints are:
A + C is odd.
A + D is a square of an integer.
B + D < 60.

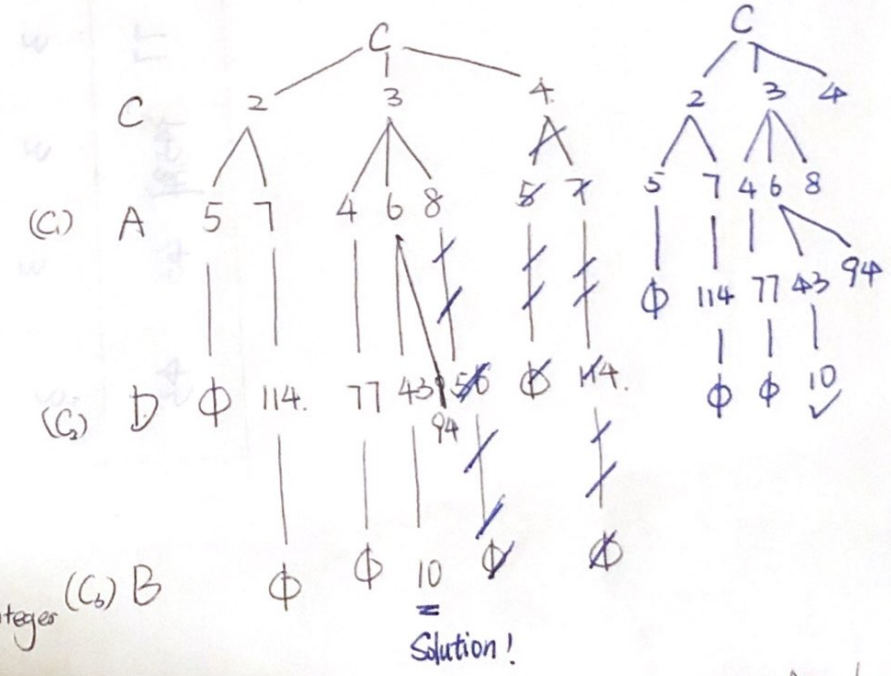
Solve this problem using the following heuristics and algorithms.

- Use backtracking search.
- For variable ordering, use MRV. If there are ties, use degree to break them. If there are still ties, break them in alphabetical order.
- For value ordering, order values from smallest to largest.
- For inference, use forward checking.

Please show the search tree and the stack of the domains (see the lectures for examples). When the search backtracks due to an empty domain, show it clearly on your search tree. Write down the final solution, if there is any.

Search tree:

Given A = {4, 5, 6, 7, 8}
B = {10, 20, 30, 40}
C = {2, 3, 4}
D = {28, 43, 56, 77, 94, 114}



Constraints:
C_1 = A + C is odd
C_2 = A + D is a square of an integer
C_3 = B + D < 60

therefore, according search tree, solution is A = 6, B = 10, C = 3, D = 43

STACK

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STACK	C=2	A=5	A=7 Constant	D=114	C=3	A=4	D=77	A=6	D=43	B=10
A={4,5,6,7,8}	{5,7}	5	7	7	{4,6,8}	4	4	6	6	6
B={10,20,30,40}	B {10}	B	B	ϕ	B	B	ϕ	B	10	10
C={2,3,4}	2	2	2	2	3	3	3	3	3	3
D={28,43,56,77, 94,114}	D	ϕ	114	114	D	77	77	{43,94}	43	43

According to Stack, we can find A = 6

B = 10

C = 3

D = 43